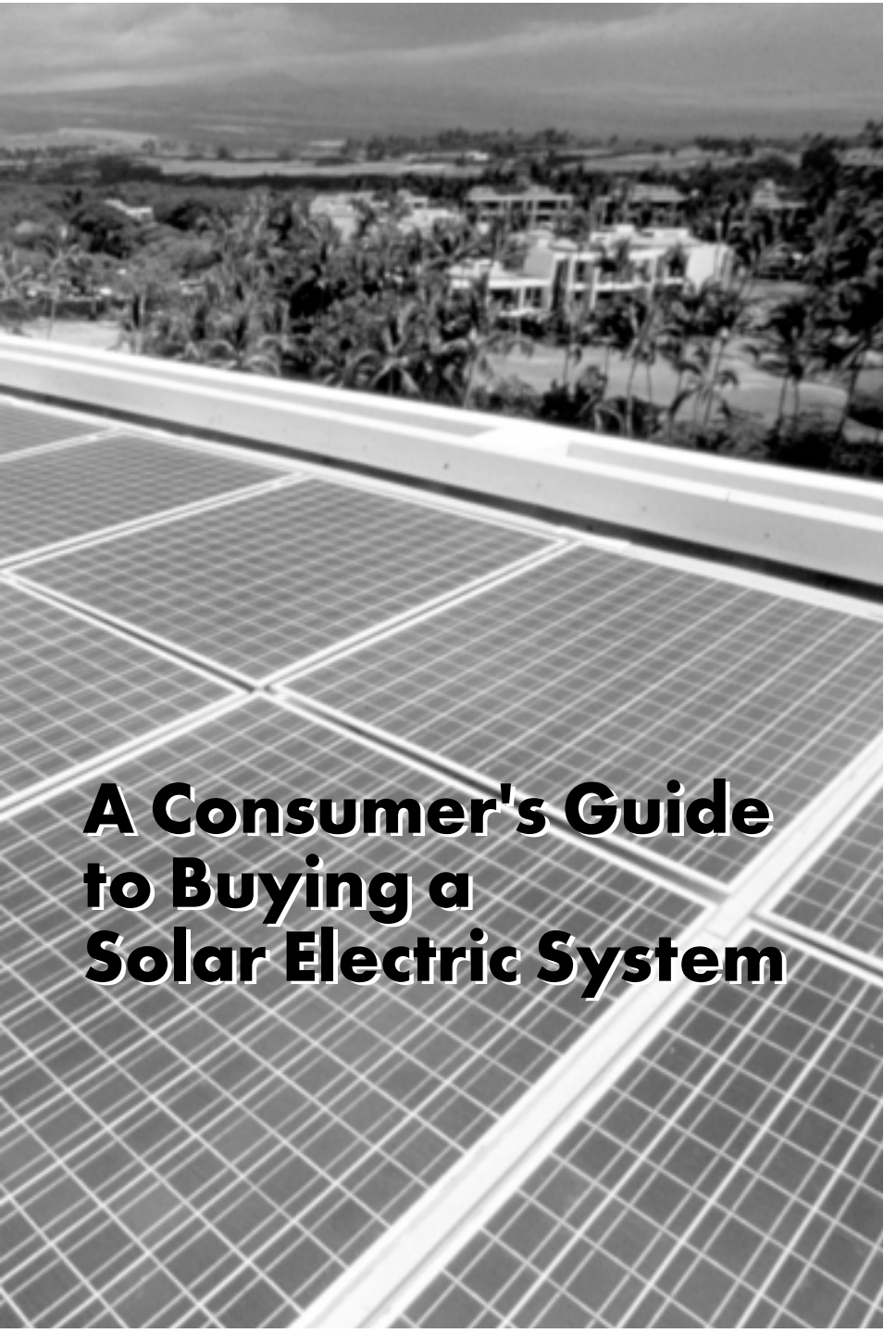


A Consumer's Guide to Buying a Solar Electric System

Are you thinking about buying a PV system for your home or business? If so, this booklet will provide basic information that you need to know. People across the nation are showing increased interest in solar electric systems for their homes and businesses. These photovoltaic—or PV—systems are reliable, pollution free, and use a renewable source of energy—the sun. Although they are still expensive, they are becoming more affordable all the time. And remember: The more energy-efficient your house, the greater the impact of a PV system. Measures such as increased insulation and energy-efficient lighting, appliances, and windows will drastically reduce your home's use of electricity.

To make PV systems even more affordable, several states are offering financial incentives through solar-rebate and other programs. And some utilities offer net metering to make PV systems even more economical. Net metering means that when your PV system generates more power than you need, the meter runs backwards resulting in an even swap for the grid power that you use at other times. In essence, you receive full retail value for all the power that your PV system generates.

This booklet is designed to guide you through the process of buying a solar electric system. A word of caution: *This is not a technical guide for designing or installing your system*—for that information, we recommend that you consult an experienced PV system designer or system supplier ("PV provider") who will have detailed technical specifications and other necessary information. A PV system can be a substantial investment, and as with any investment, careful planning will help ensure that you make the right decisions.

Contents

Background

What is a solar electric, or photovoltaic, system?

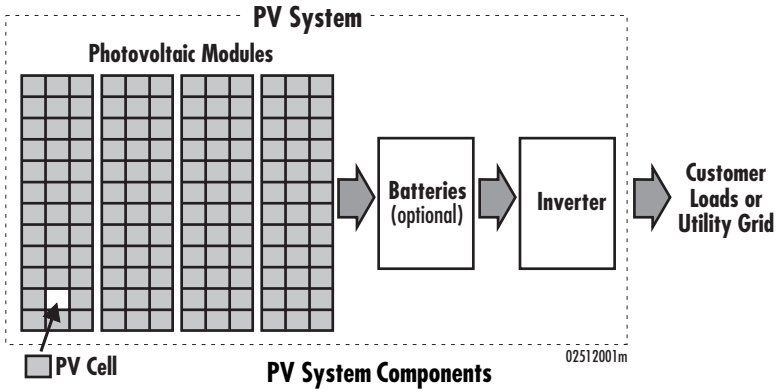
PV technology converts sunlight directly into electricity. It works any time the sun is shining, but more electricity will be produced when the light is more intense (a sunny day) and is striking the PV modules directly (when the rays of sunlight are perpendicular to the PV modules). Unlike solar systems for heating water, which you might be more familiar with, PV technology does not use the sun's heat to make electricity. Instead, PV produces electricity directly from the electrons freed by the interaction of sunlight with semiconductor materials in the PV cells.

But you don't need to understand the detailed physics of how PV works to understand its appeal: investing in PV allows you to produce your own electricity with no noise, no air pollution, and no moving parts while using a clean, renewable resource. A PV system will never run out of fuel, and it won't increase our oil imports from overseas. In fact, it may not even contribute to the trade deficit, because many PV system components are manufactured in the United States. Due to these unique characteristics, PV technology has been called "the ultimate energy source for the 21st century."

The basic building block of PV technology is the solar "cell." PV cells are wired together to produce a PV "module," the smallest PV component sold commercially, and these modules range in power output from about 10 watts to 300 watts. A PV system tied to the utility grid consists of one or more PV modules connected to an inverter that changes the system's direct-current (DC) electricity to alternating current (AC), which is compatible with the utility grid and able to power devices such as lights, appliances, computers, and televisions. You may include batteries in the system to provide back-up power in case your utility experiences a power outage.

Before you decide to buy a PV system, you should understand the current status of the technology:

First, it produces power intermittently because it works only when the sun is shining. This is not a problem for PV systems connected to the utility grid, because additional electricity you need is automatically delivered to you by your utility.



Second, if you live near existing electrical service, PV-generated electricity is usually more expensive than conventional utility-supplied electricity. Improved manufacturing has reduced the cost to less than one percent of what it was in the 1970s, but the cost (amortized over the life of the system) is still about 25 cents per kilowatt-hour. This is about two to five times the retail price that residents now pay for electricity from their utilities. A solar rebate program and net metering can help make PV more affordable, but it can't match today's price for electricity from your utility.

Finally, unlike electricity purchased month by month from a utility, PV power comes with a high initial investment and no monthly charge thereafter. This means that buying a PV system is like paying years of electric bills up front. You'll probably appreciate the reduction in your monthly electric bills, but the *initial* expense may be significant. By financing your PV system, you can spread the cost over many years, and a rebate can also lighten your load.

Are incentives available to help reduce the cost?

Yes, in many states! To get specific information, you should call one of the contacts listed on the Getting Help page at the end of this booklet. You may also find a loose insert in this booklet that provides state-by-state information on attributes and incentives, as well as contacts and their phone numbers. This information changes rapidly, and we attempt to keep it updated regularly. Another excellent source is the National Database of State Incentives for Renewable Energy (DSIRE), prepared by North Carolina Solar Center, which contains information on financial and regulatory incentives to promote the application of renewable energy technologies.

Net Metering—In some 25 states, customers who own PV systems can benefit from laws and regulations that require "net" electric meter reading. The customer is billed for the "net" electricity purchased from the utility over the entire billing period—that is, the difference between the electricity coming from the power grid and the electricity generated by the PV system. Hence, the monthly reading indicates *net* customer usage. Through net metering, the customer obtains the full retail electricity rate—rather than the much lower wholesale rate-for kilowatt-hours of PV-produced electricity sent back to the utility power grid. The consumer benefits of net metering are especially significant in areas such as Hawaii and New York, which have high retail rates. Utilities also benefit because the solar-generated energy often coincides with their peak demand.

Property and Sales Tax—Tax incentives may include exemption of sales tax on the PV system purchase, exemption of property tax, or state personal income-tax credits, which provide the greatest economic benefit to consumers by lowering high capital costs.

The U.S. government also provides financial support for PV technology through a tax credit for commercial uses of solar energy. This energy investment credit provides businesses (but not individuals or utilities) with a 10% tax credit and 5-year accelerated depreciation for the cost of equipment used to generate electricity by solar technologies.

Buydown—Rebates and buy-downs, typically based on the power of the system, help to defray high capital costs and

are justified by creating competitive, sustainable market growth. In the United States, the U.S. Department of Energy has been involved in a program known as TEAM-UP, or Technology Experience to Accelerate Markets in Utility Photovoltaics. This program has a goal of 50 megawatts and has already contracted for 8 megawatts of grid-connected PV, with supplier buy-downs and consumer rebates between $2–$4 per watt. California's Assembly Bill 1890, for example, began a consumer buy-down program in early 1998.

Residential Energy Rate—This number is the *average* retail residential rate for energy from utilities, in cents per kilowatt-hour (¢/kWh). Check your utility bill for your *actual* rate.

PV modules were installed by workmen on the Natatorium, the main swimming facility for the 1996 Summer Olympic games in Atlanta, Georgia. (Craig Miller Productions/PIX 03500)

Investing in a PV system

Why should I buy a PV system?

People decide to buy PV systems for a variety of reasons. Some want to help preserve the earth's finite fossil-fuel resources and reduce air pollution. Others would rather spend their money on an energy-producing improvement to their property than to send their money to a utility. Some people like the security of reducing the amount of electricity they buy from their utility, because it makes them less vulnerable to future increases in the price of electricity. Finally, some people just don't like paying utility bills and appreciate the independence that a PV system provides.

If you plan to build away from established utility service, you should consider the cost of installing a utility line needed to provide the utility's energy. Often, the cost of extending conventional power to your residence is more expensive than the solar option.

Whatever your reason, solar energy is widely thought to be the energy source of choice for the future, and you may be able to take advantage of a state-sponsored program to help make it your energy choice for today and tomorrow.

Is my home or business a good place for a solar system?

Can you orient your system for good performance?

A well-designed PV system needs clear and unobstructed access to the sun's rays for most or all of the day, throughout the year. You can make an initial assessment yourself, and if the location looks promising, your PV provider has the tools to trace the sun's path at your location and determine whether your home or business can make use of a PV solar system.

The orientation of your PV system (the compass direction that your system faces) will affect performance. In the United States, the sun is always in the southern half of the sky and is higher in the summer and lower in the winter. Usually, the best location for a PV system is a south-facing roof, but roofs that face east or west may also be acceptable. Flat roofs also work well for solar systems because the PV modules can be mounted flat on the roof facing the sky or mounted on frames tilted toward the south at the optimal angle.

If a rooftop can't be used, your solar modules can also be placed on the ground, either on a fixed mount or a "tracking" mount that follows the sun to orient the PV modules for maximum performance. Other options (used most often in multifamily or commercial applications) include mounting structures that create covered parking or provide shade as window awnings.

Is your site free from shading by trees, nearby buildings, or other obstructions?

To make the best use of your PV system, the PV modules must have a clear "view" of the sun for most or all of the day—unobstructed by trees, roof gables, chimneys, buildings, and other features of your home and the surrounding landscape. Note that even though the area where a system is mounted may be unshaded during one part of the day, it may be shaded during another. If this is the case, then this shading may substantially reduce the amount of electricity that your system will produce. To be eligible for some rebates, your system

must be unshaded between certain hours during certain times of the year. Some states have laws that establish your right to protect your solar access through the creation of a "solar easement."

Do you have enough area on your roof or property?

The amount of space needed by a PV system is based on the physical size of the system you purchase. Most residential systems require as little as 50 square feet (for a small "starter" system) up to as much as 1,000 square feet. Commercial systems are typically even larger. If your location limits the physical size of your system, you may want to install a system that uses more-efficient PV modules. Greater efficiency means that the module uses less surface area to convert sunlight into a given amount of electric power. PV modules are available today in a range of types, and some offer more efficiency per square foot than do others. The cost per kilowatt of higher-efficiency modules is about the same as low-efficiency modules, so this may not add to your system's price. System sizing is discussed later in this booklet and should also be discussed with your PV provider.

What kind of roof do you have, and what is its condition?

Some roof types are simpler and cheaper to work with, but a PV system can be installed on any type. Typically, composition shingles are easiest to work with, and slate is the most difficult. In any case, an experienced solar installer will know how to work on all roof types and can use roofing techniques that eliminate any possibility of leaks. Ask your PV provider how the PV system affects your roof warranty.

If your roof is older and needs to be replaced in the very near future, you may want to replace it at the time the PV system is installed to avoid the cost of removing and reinstalling your PV system. Panels often can be integrated into the roof itself, and some modules are actually designed as three-tab shingles or raised-seam metal roof sections. One benefit of these systems is their ability to offset the cost of roof materials.

How big should my PV system be, and what features should it have?

As a starting point, you might consider how much of your present electricity needs you would like to meet with your PV system. For example, suppose that

Roof Area Needed in Square Feet (shown in **Bold Type**)

PV module efficiency* (%)	PV capacity rating (watts)							
	100	250	500	1,000	2,000	4,000	10,000	100,000
4	**30**	**75**	**150**	**300**	**600**	**1,200**	**3,000**	**30,000**
8	**15**	**38**	**75**	**150**	**300**	**600**	**1,500**	**15,000**
12	**10**	**25**	**50**	**100**	**200**	**400**	**1,000**	**10,000**
16	**8**	**20**	**40**	**80**	**160**	**320**	**800**	**8,000**

0251200 2m

* Although the efficiency (percent of sunlight converted to electricity) varies with the different types of PV modules available today, higher-efficiency modules typically cost more. So, a less-efficient system is not necessarily less cost-effective.

you would like to meet 50 percent of your electricity needs with your PV system. You could work with your PV provider to examine past electric bills and determine the size of the PV system needed to achieve that goal.

You can contact your utility and request the total electricity usage, measured in kilowatt-hours, for your household or business over the last 12 months (or consult your electric bills if you save them). Ask your PV provider how much your new PV system will produce on an annual basis (also measured in kilowatt-hours) and compare that number to your annual electricity demand to get an idea of how much you will save. In the next section, we'll provide more information on estimating how much you will save.

Some solar rebate programs are "capped" at a certain dollar amount. Therefore, a solar system that matches this cap will maximize the benefit of the solar rebate.

To qualify for "net metering" in some service territories, your PV system must have a peak generating capacity of not more than typically 10 kilowatts (10,000 watts), although this peak may differ from state to state. Also, utilities may have different provisions for buying excess electricity produced by your system on an annual basis (see the section on net metering for more detail). Finally, customers eligible for net metering may vary from utility to utility; for example, net metering may be allowed for residential customers only, commercial customers only, or both.

One optional feature you might consider is a battery system to provide back-up power in case of a utility power outage. Batteries add value to your system, but at an increased price.

As you size your system, you should consider the "economies of scale" that can decrease the cost *per kilowatt-hour* as you increase the size of the system. For example, many inverters are sized for systems up to 5 kilowatts, and if your PV array is smaller (say 3 kilowatts), you may still end up buying the same inverter. Labor costs for a small system may be nearly as much as those for a large system. Therefore, it's worth remembering that your PV provider is likely to offer you a better price to install a 2-kilowatt system all at once, than to install a 1-kilowatt this year and another similar system next year-because multiple orders and multiple site visits are more expensive.

How much will my PV system save me?

The value of your PV system's electricity will depend on how much you pay your utility for electricity and how much your utility will pay you for any excess that you generate. If your utility offers net metering (and so pays the full retail price for your excess electricity), your calculation may be fairly easy because you and your utility will each pay the same price for each other's electricity. You can use the calculation box to roughly approximate how much electricity your PV system will produce and how much that electricity will be worth. Keep in mind that actual energy production from your PV system will vary by up to 20 percent from these figures, depending on your geographic location, the angle and orientation of your system, the quality of the components of your system, and the quality of the installation. Also keep in mind that you may not get full retail value for excess electricity produced by your system on an annual basis, even if your utility does offer net metering. Be sure to discuss

these issues with your PV provider. Consider asking for a written estimate of the average annual energy production from the PV system. However, you should realize that even if an estimate is accurate for an average year, actual electricity production will fluctuate from year to year due to natural variations in weather and climate.

If your utility does not offer net metering, you can still use the calculation box to determine the amount of electricity your system will produce. But determining its value is much trickier because your excess electricity will not be worth as much as the electricity you actually use. You may earn only 2 cents per kilowatt-hour—or less than half of the retail rate—for your excess power. PV systems produce most of their electricity during the middle of the day when residential electric loads tend to be small.

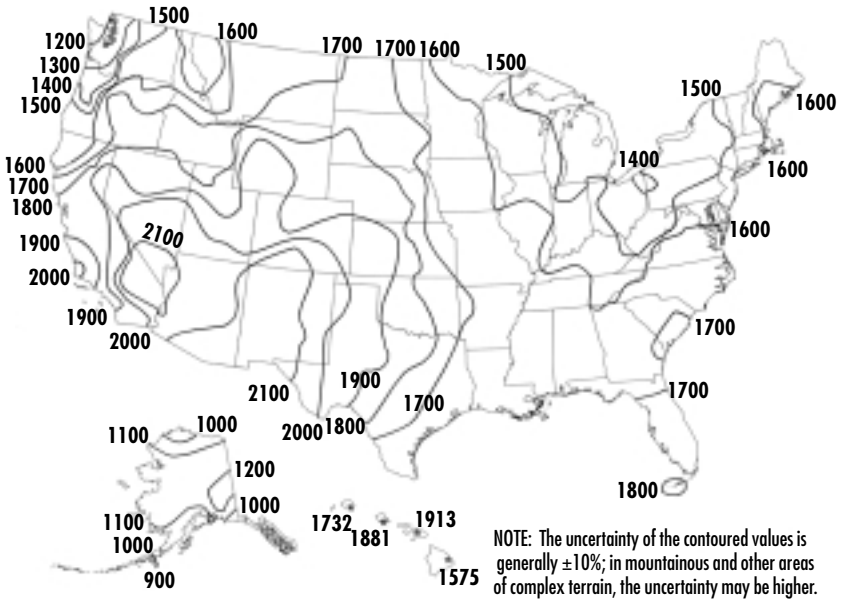
Calculating Electricity Bill Savings for a Net-Metered PV System

- Determine the system's size in kilowatts (kW). A reasonable range is 1 to 5 kW. This value is the "kW of PV" input for the equations below.
- Based on your geographic location, select the energy production factor from the map below for the "kWh/kW-year" input for the equations.

Energy from the PV system = (kW of PV) x (kWh/kW-year) = kWh/year
Divide this number by twelve if you want to determine your monthly energy reduction.

Energy bills savings = (kWh/year) x (Residential Rate)/100 = $/year saved
(Residential Rate in this above equation should be in dollars per kWh; for example, a rate of 10 cents per kWh is input as $0.10/kWh.)

For example, a 2-kW system in Denver, CO, at a residential energy rate of $0.07/kWh will save about $266 per year (1,900 kWh/kW-year x $0.07/kWh x 2 kW = $266/year).



NOTE: The uncertainty of the contoured values is generally ±10%; in mountainous and other areas of complex terrain, the uncertainty may be higher.

If net metering is not offered by your utility, you may want to size your system to avoid generating electricity significantly beyond your actual needs.

How much does a PV system cost?

There is no single answer, but keep in mind that a solar rebate and other incentives may reduce the cost. Your system's price will depend on a number of factors, including whether the home is under construction or whether the PV is integrated into the roof or mounted on top of an existing roof. The price also varies depending on the PV system rating, manufacturer, retailer, and installer.

The *size* of your system may be the most significant factor in any equation measuring your costs against your benefits. Small, single PV-panel systems with built-in inverters that produce about 75 watts may cost around $900 installed, or $12 per watt. These small systems will offset only a small fraction of your electricity bill. A 2-kilowatt system that will offset the needs of a very energy-efficient home may cost $16,000 to $20,000 installed, or $8 to $10 per watt. At the high end, a 5-kilowatt system that will completely offset the energy needs of many conventional homes may cost $30,000 to $40,000 installed, or $6 to $8 per watt. These prices, of course, are just rough estimates, and your costs will depend on your system's configuration, your equipment options, and other factors. Your local PV providers can provide you with estimates or bids.

How can I finance the cost of my PV system?

There is nothing magical about financing the cost of purchasing and installing your PV system. Although there are some special programs available for financing solar and other renewable-energy investments, most of the options will be familiar to you.

The best way to finance PV systems for homes is through a mortgage loan. Mortgage financing options include your primary mortgage, a second mortgage such as a U.S. Department of Housing and Urban Development (HUD) Title 1 loan, or a home-equity loan that is secured by your property. There are two advantages to mortgage financing. First, mortgage financing usually provides longer terms and lower interest rates than other loans such as conventional bank loans. Second, the interest paid on a mortgage loan is generally deductible on your federal taxes (subject to certain conditions). If you buy the PV system at the same time that you build, buy, or refinance the house on which the PV system will be installed, adding the cost of the PV system to your mortgage loan is likely to be relatively simple and may avoid additional loan application forms or fees.

If mortgage financing is not available, look for other sources of financing, such as conventional bank loans. Remember to look for the best possible combination of low rate and long term. This will allow you to amortize your PV system as inexpensively as possible. Because your PV system is a long-term investment, the terms and conditions of your PV financing are likely to be the most important factor in determining the effective price of your PV-generated power.

PV systems purchased for business applications are probably best financed through a company's existing sources of funds for capital purchases—usually Small Business Administration loans or conventional bank loans.

Selecting a PV installer

Who sells and installs PV systems?

In some locations, finding a PV provider can be as simple as picking up the telephone directory and looking under "Solar Energy Equipment and Systems—Dealers." Be aware, however, that many of those listings are for solar water-heating companies. Many of these companies may not be experienced in PV system design or installation. Similarly, many electrical contractors, although proficient in typical electrical contracting work, may not have expertise in PV or with residential roof-mounting techniques. *How do you identify solar electric system providers?* Here are several suggestions.

Check the *Directory of the U.S. Photovoltaics Industry*, which is posted at the following Web address: *http://www.eren.doe.gov/pv/pvdirectory.html*

- Contact the Solar Energy Industries Association for a list of solar service providers (202-383-2600).
- Contact your utility company to see which vendors it might recommend.
- Conduct a search on the Internet.

Unless you are skilled in PV installation, you should consider hiring a reputable professional contractor with experience in installing PV systems.

How do I choose among PV providers?

Compile a list of prospective PV providers. You might first consider those closest to you, because the contractor's travel costs might add to your system price. Next, contact these providers and find out what products and services they offer. The following questions may give you a good sense of their capabilities:

Has the company installed grid-connected PV systems? If not, has it installed grid-independent PV systems?

Experience installing grid-connected systems is valuable because some elements of the installation—particularly interconnection with the local utility—are unique to these systems. Because grid-connected systems are relatively uncommon, most contractors with PV experience have worked only on systems such as those that power remote cabins far from the nearest utility line. This means they have experience with all aspects of PV system installation *except* the connection with the utility grid. Although grid-connection work is different from "off-grid" work, a competent company with PV experience should not be eliminated just because it has not installed grid-connected PV systems in the past. In fact, experience with off-grid systems is valuable because grid-independent systems are more technically complicated than grid-tied systems.

How many years of experience does the company have installing PV systems?

This issue speaks for itself: A company or contractor that has been in business a long time has demonstrated an ability to work with customers and to compete effectively with other firms.

Is the company properly licensed?

PV systems should installed by an appropriately licensed contractor. This usually means that either the installer or a subcontractor has an electrical contractor's license. Your State Elec-

trical Board can tell you if a contractor has a valid electrician's license. Local building departments also may require that the installer have a general contractor's license. Consumers should call the city and county in which they live for additional information on licensing.

A solar rebate program may require that, in addition to being properly licensed, installers must demonstrate that they possess special knowledge about installing PV systems. This special knowledge may be demonstrated in one of the following ways:

- Possession of a solar contractor specialty license, issued by a local building jurisdiction, that recognizes—through testing or other means-special knowledge of PV systems.
- Certification in PV systems by a group such as the state chapter of SEIA.
- A letter from the manufacturer of the PV system stating that the installer has experience and/or training necessary to install the system properly.

Does the company have any pending or active judgements or liens against it?

As with any project that requires a contractor, due diligence is recommended. Your State Electrical Board can tell you about any judgments or complaints against a state-licensed electrician. Consumers should call the city and county in which they live for additional information on how to check up on contractors. The Better Business Bureau is another source of information on contractors.

How do I choose among competing bids?

If you have decided to get more than one bid for the installation of your PV system (and it's generally a good idea to do so), you should take steps to ensure that all of the bids you receive are made on the same basis. For example, comparing a bid for a system mounted on the ground against another bid for a rooftop system is like comparing apples to oranges. Similarly, different types of PV modules generate more electricity per square foot than others. Bids should clearly state the maximum generating capacity of the system (measured in watts or kilowatts). If possible, have the bids specify the system capacity in "AC watts" under a standard set of test conditions, or specify the output of the system at the inverter.

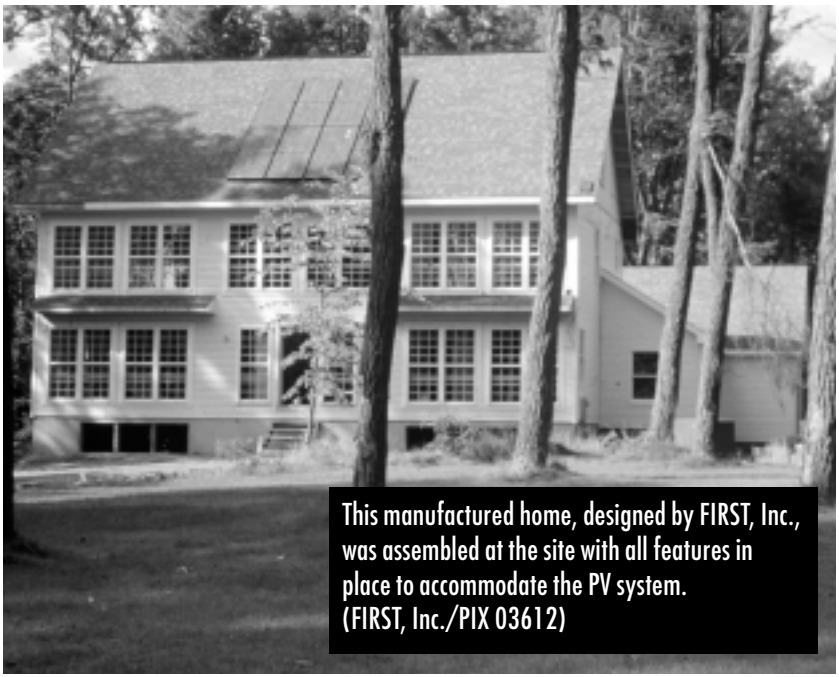
You may want to obtain some estimate of the amount of energy that the system will produce on an annual basis (measured in kilowatt-hours). Because the amount of energy depends on the amount of sunlight—which varies by location, season, and year to year—it is unrealistic to expect a specific figure. A range of ±20% is more realistic. Bids also should include the total cost of getting the PV system up and running, including hardware, installation, connection to the grid, permitting, sales tax, and *warranty*.

Your warranty is a very important factor for evaluating bids. A solar rebate program may require that systems be covered by, say, a two-year parts-and-labor written installation warranty, in addition to any manufacturers' warranties on specific components. The installer may offer longer warranties. Also ask yourself, "Will this company stand behind the full-system warranty for the next two years?"

Is the lowest price the "best deal"?

It might not be. Often, you get what you pay for. Remember that a PV company is a business just like any other, with overhead and operating expenses

that must be covered. It's always possible that a low price could be a sign of inexperience. Companies that plan to stay in business must charge enough for their products and services to cover their costs, plus a fair profit margin. Therefore, price should not be your only consideration.



This manufactured home, designed by FIRST, Inc., was assembled at the site with all features in place to accommodate the PV system. (FIRST, Inc./PIX 03612)

Before connecting a PV system to the grid

What about permits?

If you live in a community in which a homeowners association requires approval for a solar system, you or your PV provider may need to submit your plans. Gain approval from your homeowners association before you begin installing your PV system. Under the law in some states, you have the right to install a solar system on your home.

Most likely, you will need to obtain permits from your city or county building department. You will probably need a building permit, an electrical permit, or both before installing a PV system. Typically, your PV provider will take care of this, rolling the price of the permits into the overall system price. However, in some cases, your PV provider may not know how much time or money will be involved in "pulling" a permit. If so, this task may be priced on a time-and-materials basis, particularly if additional drawings or calculations must be provided to the permitting agency. In any case, make sure the permitting costs and responsibilities are addressed at the start with your PV provider.

Code requirements for PV systems vary somewhat from one jurisdiction to the next, but most requirements are based on the National Electrical Code (NEC). The NEC has a special section, Article 690, that carefully spells out requirements for designing and installing safe, reliable, code-compliant PV systems. Because most local requirements are based on the NEC, your building inspector is likely to rely on Article 690 for guidance in determining whether your PV system has been properly designed and installed. If you are among the first people in your community to install a grid-connected PV system, your local building department may not have approved one of these systems. If this is the case, you and your PV provider can speed the process by working closely and cooperatively with your local building officials to help educate them about the technology and its characteristics.

What about insurance?

Your electric utility will require you to enter into an interconnection agreement, described more fully in the next section. Usually, these agreements set forth minimum insurance requirements that you must keep in force. If you are buying a PV system for your home, your standard homeowner's insurance policy is usually adequate to meet the utility's requirements. However, if insurance coverage becomes an issue, contact one of the groups under Getting Help at the end of this booklet.

How do I get an interconnection agreement?

Connecting your PV system to the utility grid will require you to enter into an interconnection agreement and a purchase and sale agreement. Federal law and perhaps your state's public utility commission regulations require utilities to supply you with an interconnection agreement. Some utilities have developed simplified, standardized interconnection agreements for small-scale PV systems.

The interconnection agreement specifies the terms and conditions under which your system will be connected to the utility grid. These will include your

obligation to obtain permits and insurance, maintain the system in good working order, and operate it safely. The purchase and sale agreement specifies the metering arrangements, the payment for any excess generation, and any other related issues.

The language in these contracts should be simple, straightforward, and easy to understand. If you are unclear about your obligations under these agreements, you should contact the utility or your electrical service provider for clarification. If your questions are not adequately addressed, contact one of the groups under Getting Help at the end of this booklet.

National standards for utility interconnection of PV systems are quickly being adopted by many local utilities. The most important of these standards focuses on inverters. Traditionally, inverters simply converted the DC electricity generated by PV modules into the AC electricity used in our homes. More recently, inverters have evolved into remarkably sophisticated devices to manage and condition power. Many new inverters contain all the protective relays, disconnects, and other components necessary to meet the most stringent national standards. Two of these standards are particularly relevant:

- Institute of Electrical and Electronic Engineers, *P929: Recommended Practice for Utility Interface of Photovoltaic Systems*. Institute of Electrical and Electronic Engineers, Inc., New York, NY (1998).
- Underwriters Laboratories, *UL Subject 1741: Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems* (First Edition). Underwriters Laboratories, Inc., Northbrook, IL (December 1997).

You don't need to fully understand these standards, but your PV provider and utility should. It is your obligation to ensure that your PV provider uses equipment that complies with the relevant standards, so be sure to discuss this issue.

How do I get a net-metering agreement?

Some utilities offer customers with PV systems the option to "net meter" the excess power generated by the PV system. This means that when the PV system generates more power than the household can use, the utility pays the full retail price for this power in an even swap as the electric meter spins backward.

Net metering allows eligible customers with PV systems to connect to the grid with their existing single meter. Almost all standard utility meters are able to measure the flow of energy in either direction. The meter spins *forward* when electricity is flowing from the utility into the building and spins *backward* when power is flowing from the building to the utility. For example, in one utility program, customers are billed monthly for the "net" energy consumed. If the customer's net consumption is negative in any month (i.e., the PV system produces more energy than the customer uses), the balance is credited to subsequent months. Once a year, on the anniversary of the effective date of the interconnection agreement, the utility will pay the customer for any negative balance at its wholesale or "avoided cost" for energy, which may be quite small, perhaps less than 2 cents per kilowatt-hour.

Net metering allows customers to get more value from the energy they generate. It also simplifies both the metering

process (by eliminating the need for a second meter) and the accounting process (by eliminating the need for monthly payments from your utility). Be sure to ask your utility about its policy regarding net metering.

Under the federal Public Utility Regulatory Policies Act (PURPA), utilities must allow you to interconnect your PV system, and they must also buy any excess electricity you generate (beyond what you use in your home or business). If your utility does not offer net metering, it will probably require you to use two meters: one to measure the flow of electricity *into* the building, the other to measure the flow of electricity *out* of the building. If net metering is not available, the utility will only pay you a *wholesale* rate for your excess electricity. In this case, you will have a strong incentive to use all the electricity you generate so that it offsets electricity you would otherwise have to purchase at the *retail* rate. This may be a factor in how you optimize your system size, because you may want to limit the excess electricity you generate. This "dual metering" arrangement is the norm for industrial customers who generate their own power.

What about utility and inspection sign-off?

After your new PV system is installed, it must be inspected and "signed off" by the local permitting agency (usually a building or electrical inspector) and most likely by the electric utility with which you entered into an interconnection agreement. Inspectors may possibly require your PV provider to make corrections, but don't be alarmed—this is fairly common in the construction business. A copy of the building permit showing final inspection sign-off may be required to qualify for a solar rebate program.

What about warranties?

Warranties are key to ensuring that your PV system will be repaired if something should malfunction during the warranty period. PV systems eligible for some solar rebate programs must carry a full (not "limited") two-year warranty, in addition to any manufacturers' warranties on specific components. This warranty should cover all parts and labor, including the cost of removing any defective component, shipping it to the manufacturer, and reinstalling the component after it is repaired or replaced. The rebate program's two-year warranty requirement supercedes any other warranty limitations. In other words, even if the manufacturer's own warranty on a particular component is less than two years, the system vendor must still provide you with a two-year warranty. Similarly, even if the manufacturer's warranty is a limited warranty that does not include the cost of removing, shipping, and reinstalling defective components, the system vendor must cover these costs if the retailer also installed the system.

Be sure you know who is responsible for honoring the various warranties associated with your system—the installer, the dealer, or the manufacturer. The vendor should disclose the warranty responsibility of each party. Know the financial arrangements, such as contractor's bonds, that assure the warranty will be honored. Remember, a warranty does not guarantee that the company will remain in business. Get a clear understanding of whom you should contact if there is a problem. Under some solar rebate programs, vendors must provide

documentation that specifies information on system and component warranty coverage and claims procedures. To avoid any later misunderstandings, be sure to read the warranty carefully and review the terms and conditions with your retailer.

These amorphous silicon modules are fabricated on a light, flexible substrate, making them suitable for roofing shingles.
(Warren Gretz, NREL/PIX06283)

Getting help

To get more information on solar electric systems, please contact:

National Association of State Energy Officials (NASEO)
1414 Prince Street
Suite 200
Alexandria, Virginia 22314
Phone: (703) 299-8800
Fax: (703) 299-6208
http://www.naseo.org/Members/statewebs.htm

Check the above Web site to find the contact for your state energy office, which typically promotes the development and use of renewable-energy resources in your state. They may offer technical assistance, sponsor workshops and forums, and provide general information to resident energy consumers on renewable-energy resources and applications.

National Association of Regulatory Utility Commissioners (NARUC)
1100 Pennsylvania Avenue NW
Suite 603
P. O. Box 684
Washington, D.C. 20044-0684
Phone: (202) 898-2200
Fax: (202) 898-2213
http://www.naruc.org

The above Web site has a listing of state Public Utility Commissions that you may contact.

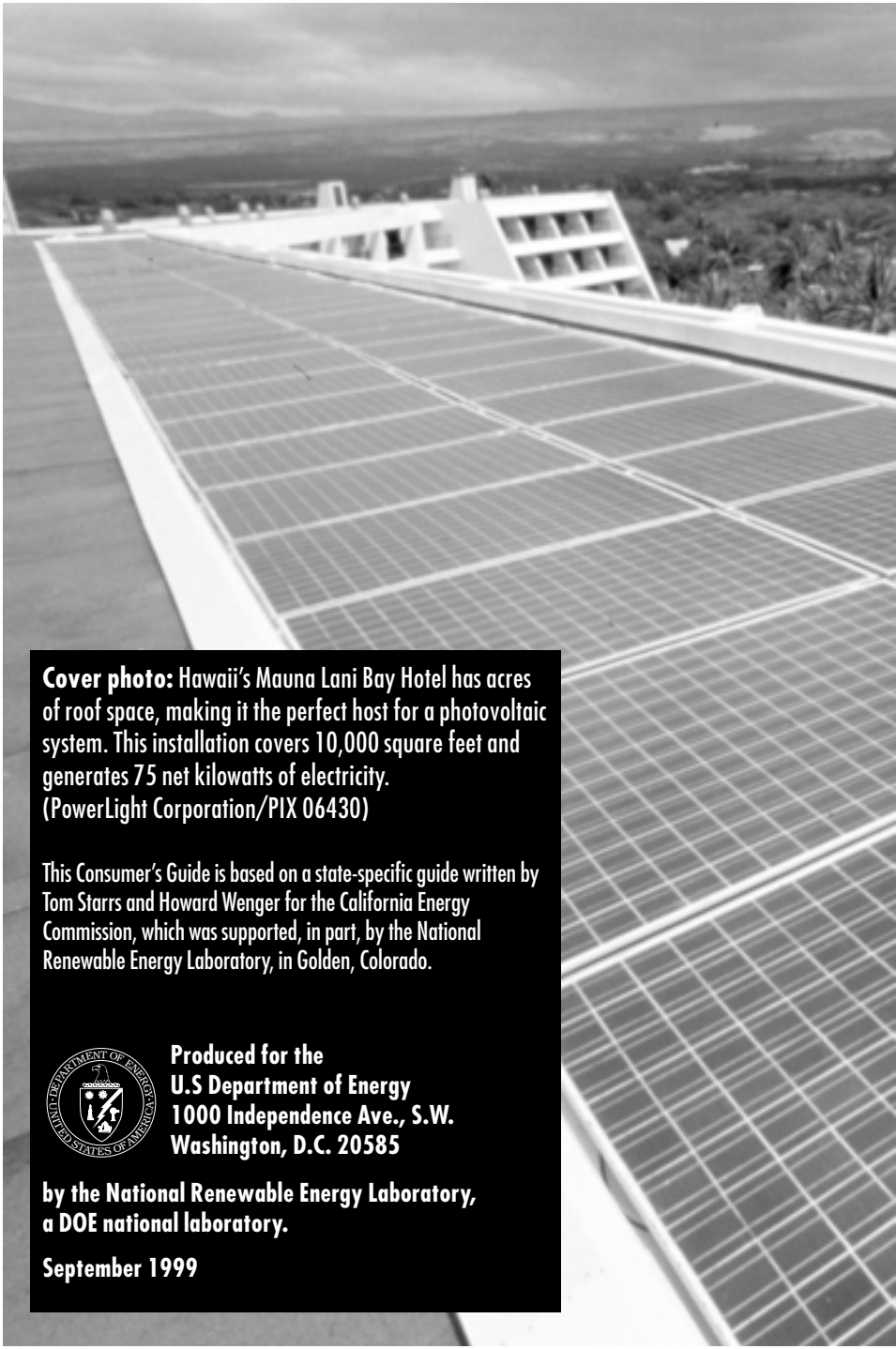
Solar Energy Industries Association (SEIA)
122 C Street, NW
4th Floor
Washington, DC 20001-2109
Fax: (202) 363-2670
http://www.seia.org

The Solar Energy Industries Association is the national trade association of the solar industry. Many states have a state chapter of the national SEIA organization, which can be checked on the above Web site.

Other Web Sites to Check

www.nrel.gov/ncpv	National Center for Photovoltaics
www.eren.doe.gov/millionroofs	Million Solar Roofs
www-solar.mck.ncsu.edu/dsire.htm	Database of State Incentives for Renewable Energy (DSIRE)

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste.



Cover photo: Hawaii's Mauna Lani Bay Hotel has acres of roof space, making it the perfect host for a photovoltaic system. This installation covers 10,000 square feet and generates 75 net kilowatts of electricity. (PowerLight Corporation/PIX 06430)

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